An Ontology-driven Mediation Approach to Multimedia Archiving and Exhibition

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Abstract

Multimedia materials are powerful in conveying information and experiences of intellectual and cultural heritages. The integrated use of image, video, sound, and text provides a rich context for learning and appreciating the documented subjects. In this paper, we present an ontology-driven approach that mediates the multi-media archiving and exhibition process among participants with different expertise and inter-related tasks. The approach enables the participation of skillful people with self-motivated interest to preserve many gradually disappearing intellectual and cultural heritages in time.

1. Introduction

Multimedia materials are powerful in conveying information and experiences on intellectual and cultural heritage. The integrated use of image, video, sound, and text provides a rich context for preserving, learning, and appreciating the documented subjects. Major efforts have been directed toward the development of multimedia based digital libraries and digital archives for preserving valuable resources in human intellectual and culture heritages [1]. Evidences abound in many national and international level projects, such as American Memory, Making of America, and The European Library.

With the wide variety and high potential of multimedia applications, multimedia research has received growing interest. Issues such as storage, representation, retrieval, authoring, and copyright protection have been actively studied [2][3]. On the other hand, the notion of subject-oriented multimedia archiving is an urgent need for domains where sources of intellectual and cultural heritages may diminish or disappear with time. Many museums and libraries have begun multimedia archiving on subjects in their collections. However, multimedia archiving requires resources, expertise, as well as time. In order to preserve many gradually disappearing intellectual and cultural heritages in time, we must enable the participation of many skillful people with self-motivated interest in this effort.

In this paper, we discuss how the subject-oriented multimedia archiving and exhibition requires team work. A model is developed and formulated as ontology for the multimedia archiving and exhibition process. We propose an approach that applies the ontology to mediate joint work and facilitate effective production by non-professional teams. The approach is implemented and used as a platform by two interdisciplinary pilot projects. In both cases, the approach is shown to be successful in orchestrating non-professional teams and enabling the production of high quality multimedia documents for archiving and exhibition.

2. Team Work Process on Multimedia Archiving and Exhibition

Producing a set of subject-oriented multimedia documents is very similar to designing a product or developing a software system. They all involve a team work process in which members with different expertise join forces to create a final entity that satisfies global requirements and constraints. Coordination issues, such as communication, task allocation, conflict resolution, and task integration, need to be resolved. In this regard, research in CSCW (computer supported cooperative work) has considered using computers as a facilitating tool for the coordination process of joint work [4][5]. Notions such as multimedia and multimodal collaboration, information management for collaboration, and asynchronous collaboration, have been explored. For subject-oriented multimedia archiving and exhibition, our purpose is to exploit non-institutional resources and allow joint forces of non-professional expertise.
Our approach focuses on developing a platform such that a self-formed team can be coached to complete the work process and produce an end result.

A project on developing subject-based multimedia documents usually involves a set of knowledge and skills areas:
- A person who has sufficient knowledge on the subject domain and material sources.
- A person who is familiar with equipments and tools to produce and manipulate digitized media.
- A person who can define subject structure and annotate the materials.
- A person who is specialized in artistic graphic layout and user interface design.
- A person who can design and implement the underlying information system.

These knowledge/skill areas do not need to be exclusive with each other. The same person may cover more than one area of work. Besides from requiring multiple knowledge/skill sets, the project is also typically represented in a process with several stages of different task focuses on work progress:
- Subject selection and planning – An interesting subject domain is selected. Possible sources of subject materials are surveyed. An initial plan on subject structure is performed. Task requirements on the following stages are discussed and specified.
- Materials acquisition – Sources of subject materials are physically accessed. And the targeted materials are digitally captured in appropriate multimedia forms according to the nature of the materials and the archiving purposes.
- Materials transformation – The acquired multimedia materials are annotated to provide information on sources and content. In addition, the multimedia materials may require further processing, such as combination, segmentation, reduction, and edition, to provide adequate support for exhibition.
- Content organization – A content structure is defined and specified such that all materials are categorized according to subject views. In addition, multi-modal materials are organized by semantic relations and are linked together. A database system reflecting the content structure is implemented to provide storage for the materials.
- Content presentation – A set of multi-modal media documents are produced with layout and artistic design. The linked multimedia documents also represent the structural view on the subject domain and provide access to the domain knowledge and experiences.

During this archiving and exhibition process, team members take on tasks in their skill areas on a consent basis. Task allocation and coordination are facilitated and coached by our proposed model.

3. Ontology as Mediation Substrate

Ontology is an agreement about shared conceptualization of a problem domain, entailed by a set of concepts, such as entities, attributes, processes, their definitions, and their relationships [6]. It involves the development and implementation of an explicit account of a shared understanding in a given domain. Such an explicit and structural representation provides a basis for dealing with the communication and coordination problems in many types of joint work. In multimedia archiving and exhibition, a self-formed team usually involves people who have not been working together before and who have disparate background contexts, domain expertise, languages, and concerns. Therefore, we develop an ontology on multimedia archiving and exhibition to facilitate effective joint work process. The ontology is then entailed in an information system that acts as a platform to provide necessary guidance and support for communication, coordination, and task composition.

3.1 Conceptualizing multimedia archiving and exhibition

The multimedia archiving and exhibition work is modeled by a set of generic concepts: stage, task, object, specialist, and role (see Figure 1). Each concept is an entity with attributes and has dependency relationships with others. At the very top level, the work is viewed as a process, which is composed of five stages – subject selection and planning, materials acquisition, materials transformation, content organization, and content presentation. Each stage represents a work focus and must produce specified intermediary results before the next stage can begin. A stage is described by its owner (role), status, and requirements. A stage is further composed of several tasks based on areas of knowledge and skills. Each task defines what is to be done and what expertise is needed. Each task is also associated with its input and output objects, and available resources. Objects are materials in different forms and are specified to organize intermediary results and coordinate task progress.
The project is to be performed by a team. The team is modeled by the concepts of specialist and role. A specialist is described by its required area of knowledge or skill and is associated to his/her responsible tasks. A role describes authority or responsibility associated with objects when a person assumes the role. Each role contributes to object creation and composition that lead to the final product.

### 3.2 Mediating the joint work process

The ontology serves as an embedded knowledge to direct and assist a team in performing the joint work process for multimedia archiving and exhibition. The work is decomposed to a set of tasks, which are assigned to persons with appropriate expertise. Task performances are coordinated and checked to ensure a sequence of progress. Task outputs are organized and accumulated to produce final outcomes – a multimedia database for the subject domain and a presentation interface for exhibition.

In particular, the use of ontology [6] provides five aspects of mediation for enabling and facilitating the multimedia archiving and exhibition work.

- **Communication:** The team is comprised of people with different expertise and background. With a shared understanding entailed by the ontology, conceptual and terminological confusion are reduced or eliminated. In addition, different viewpoints and constraints are connected by the ontology so that productive interactions are possible.

- **Specification:** Task requirements are identified and are understood by team members so that they know what to expect from each other and what to prepare for carrying out one’s tasks.

- **Operation:** Steps, procedures, tools, dependency, and objects are provided and tracked so that the team is assisted to follow through a joint work process.

- **Composition:** Relationships among tasks and objects are followed such that intermediary results can be accumulated and integrated toward the final outcomes.

- **Re-usability:** The representation of important entities, attributes, processes, and relationships encodes the functional knowledge in producing multimedia archiving and exhibition. This functional knowledge can be re-used to support many team projects for successful results.

### 3.3 Implementation

We developed a Heritage Archiving Mediator (HAM) that embedded the ontology in the domain. HAM can be used as a platform (see Figure 2) to organize team efforts, accumulate results, and produce multimedia databases and presentation interfaces. A team accesses the system via a web-based interface and is guided throughout the joint work process. Communication is supported by message boards and online talk channels. Intermediary results of the team are stored and organized so that each member can review the progress and make coordinated efforts on individual task outputs. For example, a person who is performing the task of subject materials acquisition can upload his/her work results (see Figure 3), while other members can check on the results and provide feedbacks on the adequacy of the results.

![Figure 2 Heritage Archiving Mediator](image)

![Figure 3 HAM interface](image)
results as working materials and produce an output that is directed to a designated and authorized server. In essence, HAM is a working environment in which team work on multimedia archiving and exhibition is mediated and coached to produce a subject-oriented multimedia database and its presentation interface.

4. Pilot Cases

The conceptual framework of HAM was the results of cross-disciplined knowledge interaction in a joint project. Its actual implementation was then tested used to conduct multimedia archiving and exhibition work on different subjects by two teams of graduate students and subject domain professionals. One subject concerns with a very famous and important actress in traditional Chinese opera who had been recognized as the archetypal leading actress in her times about 50 years ago. A team was led by her daughter as the subject domain expert. Other members include graduate students with expertise in media, data management, artistic design, and software. The team used HAM as the working platform and joined forces in distributed locations over two-months on a part-time basis. In the end, a multimedia database on the actress and a web-based presentation interface (http://koo.theatre.nccu.edu.tw) was produced. In particular, the database contains 61 event descriptions, 84 play profiles, 294 news reports, 325 photos of stage performance, event, and tune script, 40 minutes of theater play video clips, and 15 minutes of opera tune recording. The website was reported by a national newspaper based on its uniqueness and historical significance on Chinese opera documentation. Some highlights of the presentation interface are shown in Figure 4.

The other subject, named “history for eyes,” involves digitizing, annotating, and structuring thousands of very old journalism photos, originally stored in a little used archive room. The team was led by a journalism professor with a few graduate students of necessary expertise as members. Again, HAM was used over a three-month period and produced a multimedia database of journalism photos. The database has been considered as a valuable asset of a prestigious university. Due to space limitation, pictures and web pages of the database are omitted in the paper.

In both pilot projects, HAM was considered by each team as highly effective platform for orchestrating an interdisciplinary joint effort to produce subject-oriented multimedia database. An interesting comment by both team leaders was “HAM is like a sea shell that grows pearls.”

5. Conclusion

Multimedia archiving and exhibition are essential for preserving and sharing our intellectual and cultural heritages. The key to win the race against time and resources is to enable the participation of many skillful people with self-motivated interest in this effort. We present an ontology-driven mediation approach and an implemented system (HAM). The system has been used by two interdisciplinary projects as a platform where teams are coached to join forces in producing high-quality multimedia archiving and exhibition work. We are currently evaluating the effectiveness of the system with user studies in two digital library graduate courses.

6. References